

1      TITLE OF THE INVENTION

2            SOUND ACTIVATED LIQUID DISPLAY DEVICE

3      FIELD OF THE INVENTION

4            The invention relates to sound activated liquid display devices, such as  
5            lamps.

6      RELATED APPLICATION

7            Provisional application 60/267910 filed February 9, 2001, from which  
8            priority is claimed .

9      BACKGROUND OF THE INVENTION

10           Liquid display lamps of the general type which comprise a liquid  
11           container with a transparent wall portion in which two immiscible liquids having  
12           different visual characteristics and specific gravities or densities are mingled or  
13           merged for viewing through the wall portion to provide an interesting visual  
14           effect are well known and have been sold worldwide in large numbers for very  
15           many years.

16           U.S. patent 3,387,396, issued 1968 to Smith, the disclosure of which is  
17           incorporated herein by reference, describes one version in which the first,  
18           denser liquid can be a wax or jelling agent having a melting point above  
19           ambient/room temperature and normally resting as a mass at the bottom so  
20           that a portion thereof melts when heated from below by the lamp bulb, forming  
21           one or more globules of reduced density which separate, floating up into  
22           circulation and temporary suspension in the first liquid before cooling and  
23           falling back to the bottom of the container to coalesce with the remainder of the  
24           second liquid mass.

25           The rate of separation and mingling of the denser liquid with the less  
26           dense liquid is substantially constant as a constant heat source is taught, but  
27           could not change/react quickly even if a variable heat source were utilized as  
28           heat transfer rates are inherently relatively slow.

1        SUMMARY OF THE INVENTION

2           It is an object of the invention to provide a sound activated liquid display  
3 device in which the rate of mingling of two or more immiscible liquids of  
4 different densities and visual characteristics changes quickly in response to  
5 sounds, for example, music and voices.

6           According to one aspect, the invention provides a display device  
7 comprising a liquid container with a transparent wall portion containing two  
8 immiscible liquids having different visual characteristics and different specific  
9 gravities or densities and/or different viscosities and means responsive to  
10 changes in one or more sound parameters in the vicinity of the device, such as  
11 changes in volume or frequency, for injecting/circulating/mingling one liquid into  
12 another at rates related to the sound changes, for viewing through the wall  
13 portion to provide an interesting visual effect that reacts to music or voices.

14          One liquid can be injected into the other for dispersion and suspension  
15 therein as one or more distinct globules at rates and sizes determined by  
16 deviations from ambient sound levels.

17          The introduction of one or more liquids into another may be  
18 accomplished by one or more respective pumps, valves, injectors, or gravity-  
19 fed devices. Thus, a less dense liquid may be injected downwards into a  
20 denser liquid from the top, subsequently floating to the top, and a denser liquid  
21 may be injected upwards from the bottom, subsequently sinking. The  
22 immiscible liquids may, for example, be oil and water and, usually, more  
23 colored liquids are injected into less colored or clear liquids. By using multiple  
24 liquids and injecting means, a display with great, even rhythmic, movement  
25 can be produced with each liquid of a different specific gravity or viscosity  
26 reacting to a different sound frequency and or sound level.

27          The display device may include a lamp and means may also be  
28 provided to change the level of illumination provided by the lamp in response to  
29 changes in one or more sound parameters in the vicinity of the device.

30          Thus, the display device may include one or more pumps and/or valves  
31 that are controlled by an electronic circuit which includes: a microphone, pre-  
32 amp, AGC, selective frequency filters and motor and illumination control circuit.

1        According to another aspect, the invention provides a method of  
2        providing a liquid display by co-mingling immiscible liquids of different  
3        appearances at rates determined by changes in sound parameters particularly  
4        in the audio range.

5        **BRIEF DESCRIPTION OF THE DRAWINGS**

6        Specific embodiments of a sound activated liquid display lamp according  
7        to the invention will now be described by way of example only with reference to  
8        the accompanying drawings in which:

9              Fig 1 is a perspective view of a front of an operating liquid display lamp,  
10        which view which is common to all embodiments;

11              Fig 2(a) - (c) are schematic transverse cross-sectional views of first,  
12        second and third embodiments taken along a central vertical axis of the display  
13        device corresponding to line 2-2 of Fig 1;

14              Fig 3 is a block diagram of control circuitry of the display device.

15              Fig 4 is a schematic exploded perspective view of another embodiment;  
16        and ,

17              Fig 5 is a block diagram of alternative control circuitry

18        **DESCRIPTION OF PARTICULAR EMBODIMENTS**

19        As shown in Fig 1, the display device comprises a generally bottle-  
20        shaped, container 1 made of clear plastic (or glass) with an opaque, plastic  
21        decorative cap 2 with globules 4 of an injected, first, denser liquid sinking  
22        through a second immiscible liquid 5 filling the container 1, and an opaque,  
23        plastic, receptacle-form base 6 which masks from view a  
24        reservoir/accumulation 4' of the denser liquid resting adjacent the bottom of the  
25        container. Mounted on the front of the base are a knob 7 for controlling the  
26        frequency response, switch 8 for switching the pump between sound activated  
27        and randomly activated states and switch 9, a three way switch for switching  
28        the lamp between off/on steady and sound responsive states.

29        In the first embodiment shown in Fig 2A, an electric in-line fluid pump 11  
30        is mounted within the base and has inlets and outlets 12, 13, respectively

1 communicating with the reservoir 4'. An electric bulb and reflector assembly 15,  
2 16 is also mounted within the base adjacent the rear with the reflector 16  
3 arranged to direct the bulb light upwards through the bottom of the container.  
4 Operation of the pump in response to changing sounds causes denser liquid of  
5 the reservoir 4' to be sucked into the inlet 12 and to spout intermittently from  
6 the outlet 13 with a geyser-like effect.

7 In the second embodiment shown in Fig 2B, the container 1 also holds a  
8 third liquid, immiscible with, of greater density than, and having a different  
9 appearance than the other liquids, accumulated on the bottom of the container  
10 as another reservoir layer 17' below the first liquid reservoir 4'. Dual  
11 submersible electric fluid pumps 18, 18', (manufactured by Beckett of Irving,  
12 Texas) are mounted at different levels within the container itself so that their  
13 respective inlets (not shown) communicate respectively with reservoirs 4' and  
14 17' of the first and third liquids, respectively, and respective outlets 19, 19'  
15 communicate with the second, least dense liquid 5 for injecting the more dense  
16 liquids therein in response to changes in audible sounds. A bulb and reflector  
17 assembly 21, 22 is also mounted within the base aligned centrally below the  
18 container with the reflector 16 arranged to direct the bulb light upwards through  
19 the bottom of the container.

20 In the third embodiment shown in Fig 2C, a single submersible  
21 (Beckett) pump 18 is mounted in the container with an inlet (not shown) and  
22 outlet 19 communicating with the first liquid reservoir 4' and less dense liquid 5,  
23 respectively. A bulb 23 in a clear liquid-tight housing is submerged within the  
24 container 1. Operation is similar to the other embodiments. In the second and  
25 third embodiments the pump outlets can be below the levels of the reservoirs  
26 of denser liquids, preferably, thereby concealed from a spectators view.

27 In all embodiments, a control circuit board 24 carrying circuitry indicated  
28 in Fig. 3 is mounted within the base.

29 As shown in Fig. 3, an output signal from a microphone 31, (located  
30 within or remotely from the display device) is connected to amplifier 32 and a  
31 desired frequency range is selected by filter 33. The filter 33 can be of low,  
32 band, or high-pass type, fixed or variable, depending on the frequency range of

1 interest. For example, a 200Hz low-pass filter can be used to extract the beat  
2 from dance music. A 100-900Hz bandpass filter can be employed to extract  
3 the syllabic content of speech, etc. The short-time amplitude envelope of the  
4 filtered signal is detected by detector 34. This envelope is then presented  
5 simultaneously to long-time averager 35 and attenuator 36. The long-time  
6 averager 35 creates a DC reference signal proportional to the average sound  
7 level which reference signal is compared by comparator 37 with an attenuated  
8 version of the short-time envelope. When the short-time envelope momentarily  
9 rises above the reference average, the comparator changes state, activating  
10 pump power control 38 causing electric power 44 to be delivered to a pump 11  
11 or 18,18', and optionally a lamp 15, 21 or 23 . As a result of the operation of  
12 attenuator 36, the short-time envelope must overcome the level difference  
13 created by the attenuator to trigger the comparator 37.

14 The pump may also be controlled by automatic means. Switch 8 admits  
15 the signal from random signal generator 42 which produces pulses at  
16 perceptibly random intervals to control the action of the pump/lamp when  
17 sound activation is not desired.

18 Multiple separate chains of components 33-43 may be connected to the  
19 output of amplifier 22 to implement a plurality of channels operating separate  
20 pumps such as pumps 18 and 18' in the same container of the second  
21 embodiment shown in Fig 2B,. The type and/or cut-off frequencies of each  
22 filter 33 may be different for each channel resulting in a unique response by  
23 each pump 18 or 18' to audio stimuli from the microphone 31.

24 The pump is run whenever significant sound events occur in the vicinity  
25 of the display unit. A significant sound event is defined as any sound within a  
26 selected frequency range which rises a fixed threshold value above the  
27 ambient sound level. Useful thresholds lie between 2-6db.  
28 The viscosity and time base of the averager largely determine the continuity  
29 and length of the geyser, the number and size of the globules.

30 It is important to chose the relative viscosities of the liquids correctly as  
31 the speed of globule descent is controlled primarily by the relative viscosities.  
32 In one embodiment, the liquid 5 of less density can be petrolatum and the

1 more dense liquid 4 can be propylene glycol.

2 In an alternative, (not described) louder music within a selected  
3 frequency range could cause the control circuitry to supply more power to the  
4 pump, resulting in a taller liquid spout being injected than softer music, the  
5 amplitude of the spout being modulated by the sound pressure level (SPL).

6 In a fourth embodiment, shown in Fig 4, a magnetic drive pump is  
7 employed as the provision of a magnetic coupling eliminates the conventional  
8 shaft seal and the risk of leakage associated therewith. The polycarbonate  
9 container has an upper, clear-walled viewing portion 45 and an opaque pump  
10 and lamp mounting base portion 46. The upper portion 45 is molded with a top  
11 filler opening 47 with a threaded neck closed by a threaded cap 48 and a  
12 rebate 49 providing a seat for a decorative cover 50. The bottom has a knife  
13 edge rim 51 below a peripheral mounting shoulder 52. When assembled, the  
14 knife edge rim 51 of the container is ultrasonically welded (alternatively,  
15 cemented) inside a grooved upper lip 57 of a peripheral wall of the cylindrical  
16 motor and lamp mounting base portion 46

17 The magnetic drive pump comprises a first sub-assembly 60 and a  
18 second sub-assembly 61, mounted outside and inside the container,  
19 respectively. The first sub- assembly 60 comprising an electric motor 62 with a  
20 drive shaft 63 and a cylindrical drive magnet 64 with one axial end mounted  
21 thereon. The second sub-assembly 61 comprises an impeller housing 65 with  
22 a liquid inlet and a liquid outlet 66, a cylindrical driven magnet 67, and an  
23 impeller 68 with one axial end fixed to the driven magnet 67. The base portion  
24 46 is integrally molded with a holder 70 for lens 71, depending mounting legs  
25 72 a seat for the impeller housing 65 and an outwardly protruding, cylindrical  
26 magnet housing portion 69 with a blind, outer end. In the assembly, the drive  
27 magnet 64 and the driven magnet 67 are mounted for rotation in coaxial,  
28 substantially concentric relation surrounding and within the cylindrical housing  
29 portion 59, respectively, so that the drive magnet and driven magnet are  
30 magnetically coupled together, whereby the impeller is rotated by the electric  
31 motor.

32 The impeller is mounted for rotation on a stationary spindle 75 mounted

1 coaxially in the cylindrical housing portion housing 59 with upper and lower  
2 axial ends of the spindle captivated by the impeller housing and the blind end,  
3 respectively.

4 A substantially cylindrical base member 76 is formed with a side  
5 window 77 on an upper wall part for receiving a mounting bracket 78 for a lamp  
6 79 and, an arcuate mounting flange 81 for assembly with a base plate 82 of  
7 complementary shape and molded with upstanding mounting posts 83 of  
8 complementary shape to the mounting legs 72.

9 A circuit board 84 carrying the operating circuitry and a step down DC  
10 power supply (transformed/rectifier) 86 is mounted on the base plate 82.

11 To assemble the container with the base member 77, the mounting  
12 portion 58 carrying the electric motor is seated on the upper rim of the base  
13 member 77 with the legs 72 inserted therethrough, mated with the posts 83 on  
14 the base plate, so that the base member conceals the elecric motor and circuit  
15 board from view within the base member.

16 The device uses two or more insoluble liquids to achieve the effect of  
17 the lower heavier fluid being injected into the upper lighter liquid . This liquid  
18 injection provides the appearance of a geyser, and under electronic control this  
19 injection creates a very entertaining visual display.

20 In a first example, the liquid of greater specific gravity is a combination  
21 of Propylene Glycol, Glycerin and Water mixed in any combination of quantities  
22 to achieve the desired viscosity. The addition of more water provides a more  
23 foamy opaque, mixture which may be desirable because it reflects light better  
24 than a mixture that is clearer.

25 The liquid of less specific gravity or density is a paraffinic oil such as  
26 Lamplight Farms, Ultra-Pure Lamp Oil, a petroleum hydrocarbon consisting of  
27 98% normal paraffin (liquid wax). It consists of high-purity, linear saturated  
28 paraffin blends of various molecular weights in the carbon range of C10-C16  
29 and of low viscosity.

30 Either solution may be colored with an appropriate dye. The more  
31 dense, lower phase solution with a water-soluble food coloring agent and the  
32 upper phase with an oil based dye such as Abbey Products, of Philadelphia,

1 PA, Acol Red.

2 In a second preferred example, the more dense liquid is chlorinated  
3 paraffin, such as Ferro Corporation of Hammond, Indiana, CW 45-50 and the  
4 less dense liquid is distilled water.

5 Anti-growth additives such as alcohol or chlorine may be added to the  
6 water to prevent bacterial, mold or algae growth.

7 Either solution may be colored with an appropriate dye. The more solution with  
8 an oil based dye such as Abbey Products, Acol Red and the less dense liquid  
9 with a water soluble food coloring agent.

10 In an alternative control circuit shown in fig 5, the averager and  
11 attenuator are replaced by a DC reference voltage source derived from the DC  
12 voltage supply and, a differentiating circuit.

13 Following amplitude detector 34, is a differentiator circuit which has a  
14 time constant arranged such that rapidly changing signals are passed with little  
15 attenuation and slowly rising and falling signals are suppressed resulting in the  
16 differentiator's output remaining at or about zero. This signal is applied to the  
17 non-inverting input of comparator 37. The inverting input of comparator 37 is  
18 held at a fixed DC reference voltage. Because the DC reference voltage 5 is  
19 greater than the quiescent output of differentiator 6, comparator 37 usually  
20 remains off (logic low). If a significant (above the ambient) audio signal which  
21 is detected by 34 and passed by differentiator 96 exceeds the fixed DC  
22 threshold level, comparator 37 will change state (to logic high) resulting in the  
23 activation of the pump power control 38, the pump and the light

24 In alternative lamp/light control, a transient decay circuit is employed to  
25 provide gradual lamp fade in synchronism with the rate at which the globules of  
26 more dense liquid fall back through the less dense liquid after spouting up therein  
27 in geyser-like manner. The (incandescent) lamp 79 is driven by a conventional  
28 voltage controlled AC dimmer circuit . When comparator 37 goes to logic high, a  
29 capacitor 96 is charged through diode 95 and held charged for the duration the  
30 comparator remains in that state. When comparator 37 returns to logic low,  
31 capacitor 16 discharges through resistor 17 with a time constant arranged to be  
32 similar to the time taken for the liquid in the vessel to return to its quiescent state.

1      The voltage on capacitor 96 controls the voltage-controlled AC dimmer circuit (not  
2      shown) so that in response to a significant audio signal, the denser liquid 4 is  
3      pumped up through the less dense liquid 5 simultaneously with the full illumination  
4      of lamp 79. When the audio signal ceases, comparator 37 returns to its logic low  
5      state resulting in the de-activation of the pump. The denser liquid is then falling  
6      back to the bottom of the container, taking a few moments as determined by the  
7      viscosity of the liquids. During this brief period, capacitor 96 controlling the  
8      dimmer is discharging through resistor 97 causing light 78 to slowly dim back to  
9      darkness.

10     The disclosure of provisional application 60/267910 filed February 9,  
11     2001, from which priority is claimed, is incorporated herein by reference.